

Space Weather Technical Forecast

Issued on Friday, 23 December 2022 at 00:35 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of M-class flares and slight chance of G1/Minor Geomagnetic Storms. Fluence likely increasing.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with a couple of minor Common-class flares, the largest of which came from AR3171 in the northeast. There are currently 7 sunspot regions on the front facing disc, with AR3163 now rotating off the southwest limb but a new region rotating on in the northeast. AR3171, despite only having penumbra on its one main spot, has some minor magnetic complexity with a beta-gamma formation. AR3169 is now a unipolar region with its trailing spots decaying. All other regions remain small and simple at present. No Earth directed CMEs were observed in available imagery during the period. An eruption from near AR3169 around 22/1700 UTC has not yet shown in coronagraph imagery, but has the potential to be Earth-directed if it has not been re-absorbed.

Solar Wind / Geomagnetic Activity: The solar wind as measured by DSCOVR at L1 is showing gradual transition into a weak High Speed Stream (HSS), likely from CH55/+. Wind speeds have been mostly slightly elevated, rising slightly from near 400 km/s to around 500 km/s. The density has been mostly average. The total IMF, Bt, is currently weak, but became mostly moderate between 22/1130-2230 UTC. The Bz is varying weakly, but varied moderately for a time between +8/-9 nT. The phi angle was mostly positive (away from the Sun). Resultant geomagnetic activity was Quiet to Unsettled (Kp 1-3), with an Active (Kp 4) interval 22/1800-2100 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at Background levels. High energy electron flux (greater than 2 MeV), as observed by GOES16, was at mostly Background levels. The associated 24-hour fluence continued on a steady trend well below Active ($1e8$ integrated pfu). Observed fluence at 23/0001 UTC was $1.53e6$ integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to remain Low, with occasional C-class flares. There remains a chance of M-flares throughout the forecast period as departing spots are anticipated to be replaced by new regions from the far side.

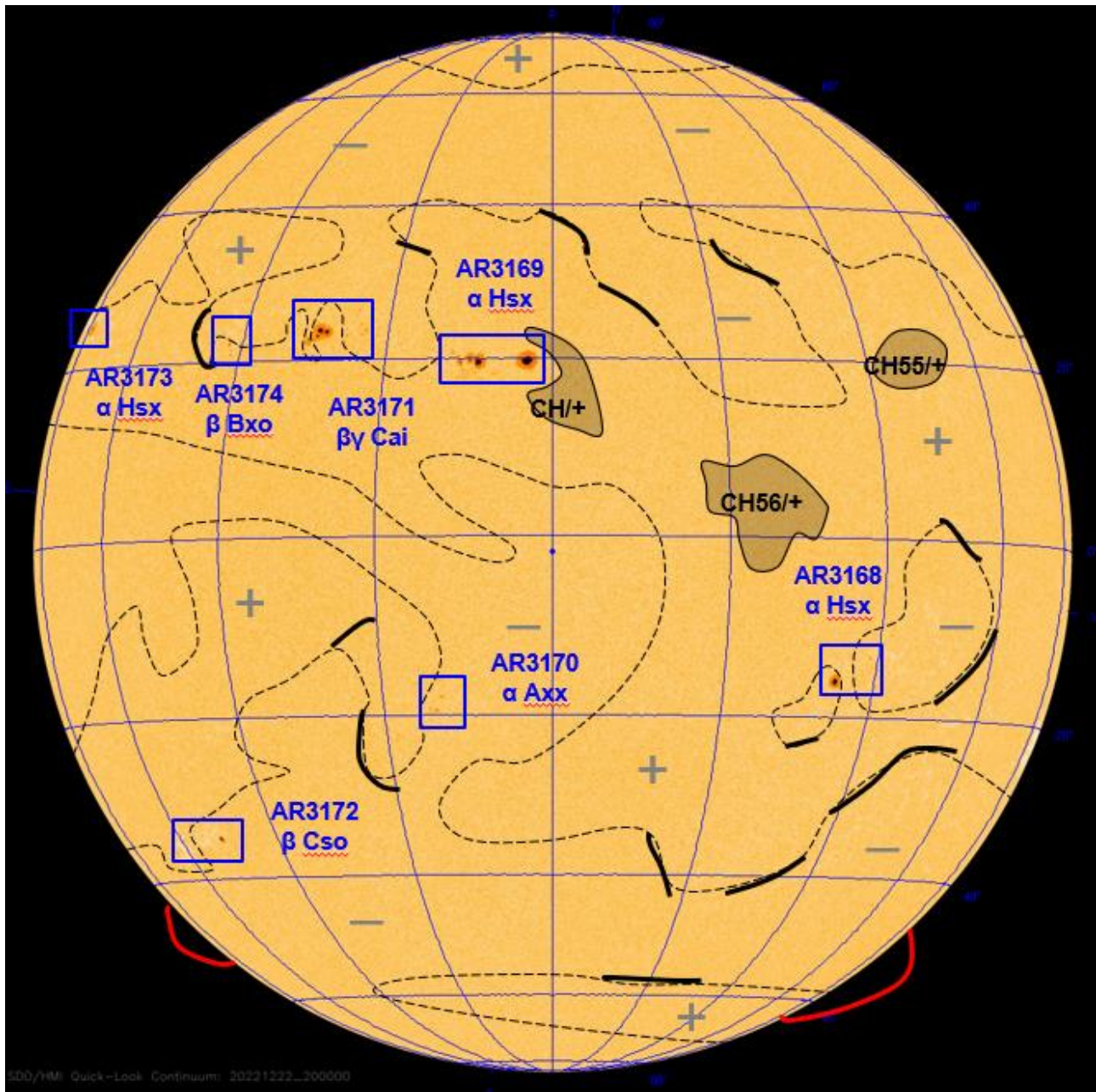
Solar Wind / Geomagnetic Activity: No CMEs currently feature in the forecast. Solar winds are forecast to be slightly elevated or elevated through the period due to ongoing HSS effects. Quiet to Unsettled geomagnetic activity is most likely, with spells of Active. There is a slight chance of G1/Minor storms throughout, most likely as Earth transitions to the HSS from CH56 later on Day 1 or early on Day 2 (23-24 Dec) and again on Day 4 (26 Dec) with the HSS from the unnumbered coronal hole.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels throughout, although there is slight chance of this reaching the S1/Minor Storm level should any notable flares occur. High energy (greater than 2 MeV) electron flux is expected to remain at Background levels throughout. The associated 24-hour fluence is expected to remain at Background levels throughout. The associated 24-hour fluence is expected to remain at Background levels throughout.

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MeV) electron flux has the potential to increase due to HSS influence, perhaps reaching High levels on the diurnal peaks. The associated 24 hour electron fluence is forecast to remain below the Active ($1e8$ integrated pfu) threshold, probably with a rising trend, however it is likely that it will stay below Active until next week.

Figure 1. Solar Analysis Valid 22/2000 UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - γ - δ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

No CMEs currently feature in the forecast, however there have been numerous flares and peripheral CMEs recently and thus a transient event cannot be ruled out. An eruption from near AR3169 around 22/1700 UTC has not yet shown in coronagraph imagery, but has the potential to be Earth-directed if it has not been re-absorbed. More imagery is needed before it can be fully assessed.

Solar winds are forecast to be slightly elevated or elevated through the period due to the combination of HSS effects from CH55/+, CH56/+ and then a further unnumbered coronal hole near centre disc. This is in broad agreement with MOSWOC Enlil and the 27-day persistence model, and also with STEREO-A data, although the timing of peaks and troughs in wind speed should not be taken literally from any of these sources.

Quiet to Unsettled geomagnetic activity is most likely, with spells of Active. There is a slight chance of G1 Minor storms throughout, most likely as Earth transitions to the HSS from CH56 later on Day 1 or early on Day 2 (23-24 Dec) and again on Day 4 (26 Dec) with the HSS from the unnumbered coronal hole.

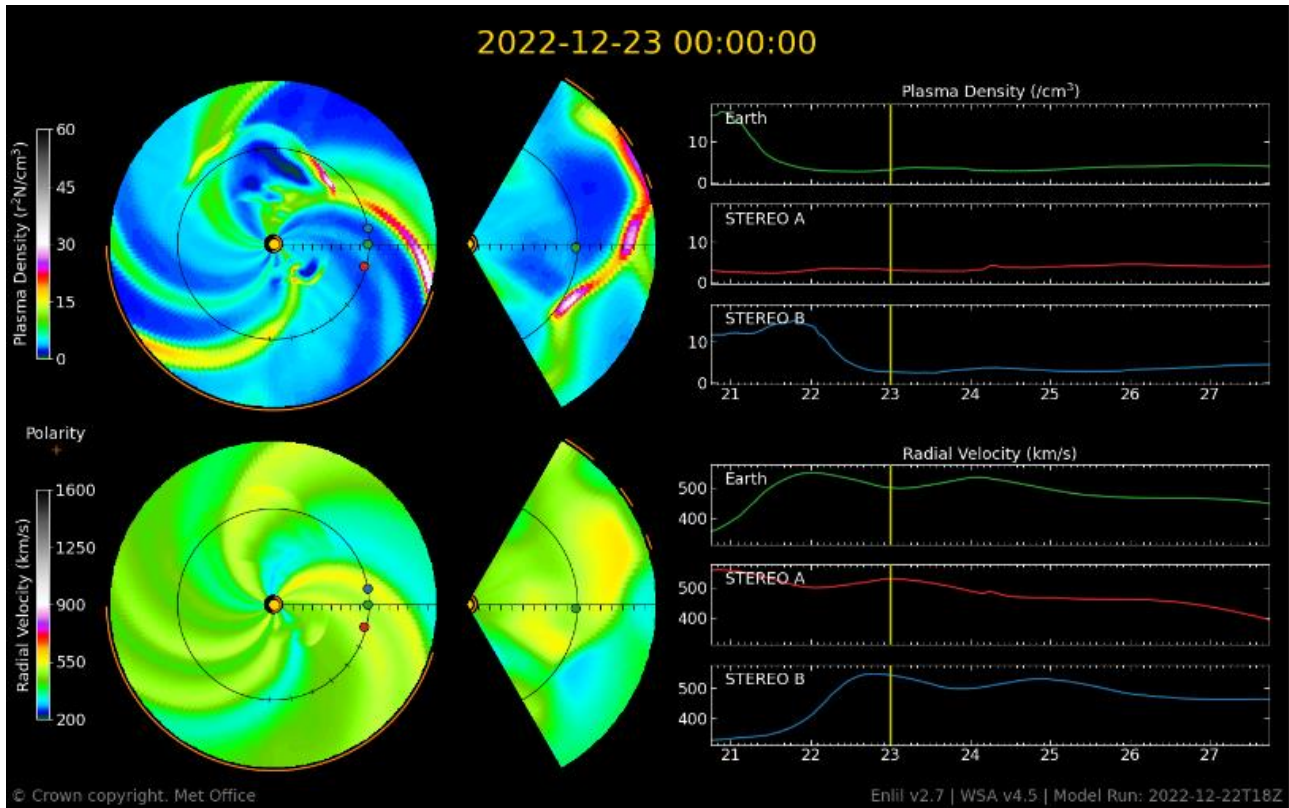
Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	20	10	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
*	*	*	*	*	*	*



Figure 2: MOSWOC Enlil showing elevated or slightly elevated wind speeds through the next few days.



Radio Blackouts - X-Ray Flares:

Solar activity has been Low over the past 24 hours with a couple of minor C-flares. There are currently 7 sunspot regions on the visible disc. AR3163 is now rotating off the southwest limb, but there is a new region (AR3173) rotating onto the northeast limb. AR3169 (Hsx/Alpha) in the northeast is now the largest region, but has recently lost its trailing spots and is now a unipolar region. AR3171 (Cai/Beta-Gamma), just east of AR3169, is showing some minor magnetic complexity. All other regions appear small and simple at the present time.

The influence from AR3163 will reduce in the next couple of days, but there are another couple of potential regions to rotate on in that time. As such, a chance of M-class flares is kept consistent throughout.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	25	25	25
Very Active	R3 to R5 X Class	No	2	2	2	2

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is expected to remain at background levels. However, there is a slight chance of an enhancement reaching the S1 Minor Storm level. Although some spots have now rotated off and their influence on the forecast will reduce, further spots moving across the disc into the western hemisphere maintain a level of risk through the period.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy (greater than 2 MeV) electron flux as observed by GOES-16 is currently at largely background levels. Enhancements in the solar wind from coronal hole features through this period have the potential to result in increased electron counts, perhaps reaching High levels on the diurnal peaks.

The associated 24 hour electron fluence is forecast to remain below the Active ($1\text{e}8$ integrated pfu) threshold, but probably with a rising trend. On the previous rotation which was similar in terms of coronal holes, the fluence rose on the equivalent of Day 2 (24 Dec) but didn't quite reach Active for several more days. As such, fluence will probably rise during the period, however it is likely that it will stay below Active until next week. MOSWOC REFM is currently showing a fairly level trend through the next three days, but this is likely because it hasn't yet fully assimilated the recent rise in wind speeds.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	5	10	30	30
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 3: MOSWOC REFM is still showing a fairly level forecast trend (white), likely because it hasn't yet fully assimilated the recent rise in wind speeds. Recurrence from last rotation (yellow) suggests a rise below Active.

